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Reicher

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(54) **EXAM TYPE MAPPING**

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G06N 5/02 (2006.01)

(52) **U.S. Cl.**
CPC ***G06N 5/02*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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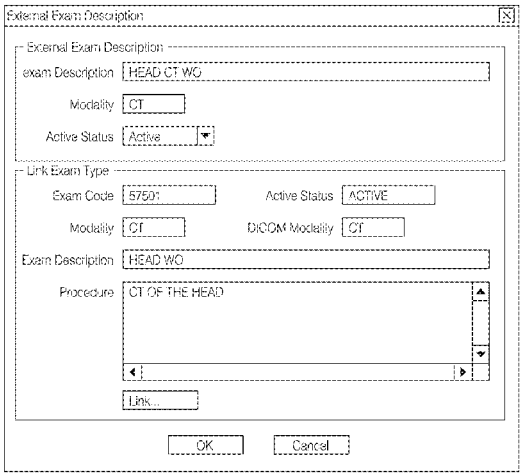
(57) **ABSTRACT**

Provided herein are various systems and methods of using an exam type data structure to map exam types in various formats to master exam types that may be associated with customized rules or other features.

27 Claims, 9 Drawing Sheets



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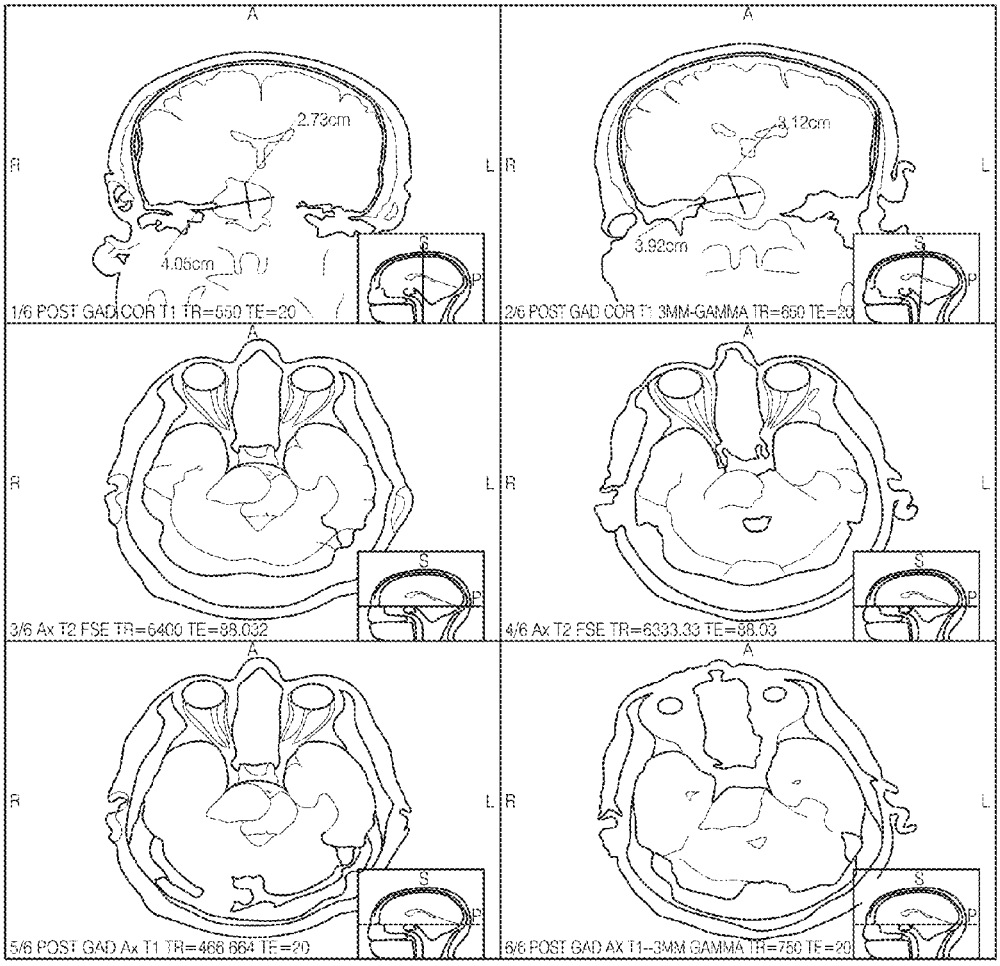
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P
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4/6 Ax T2 FSE TR=6333.33 TE=98.03
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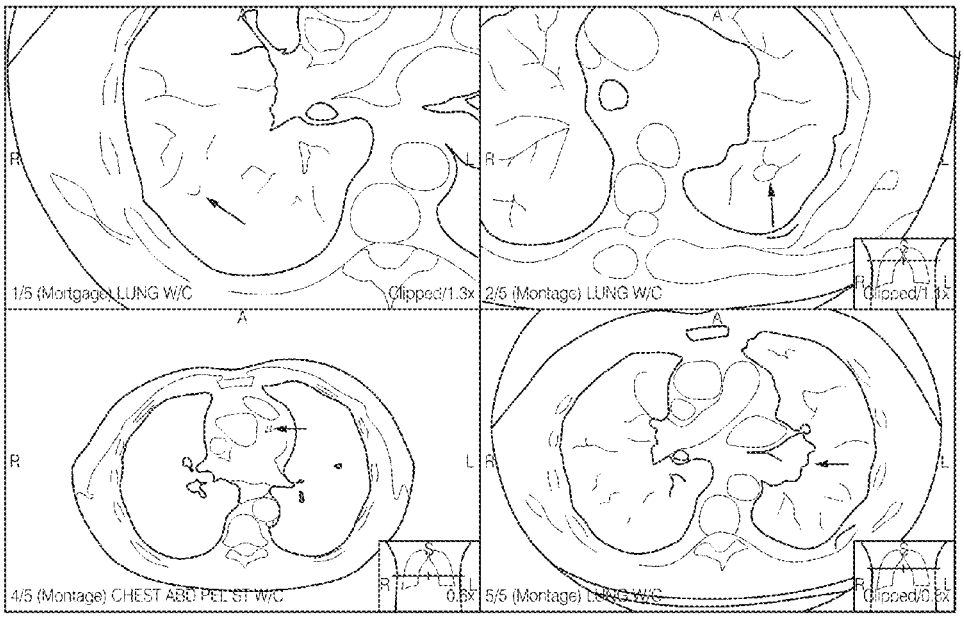
FIG. 1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Clipped/1.3x
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FIG. 2

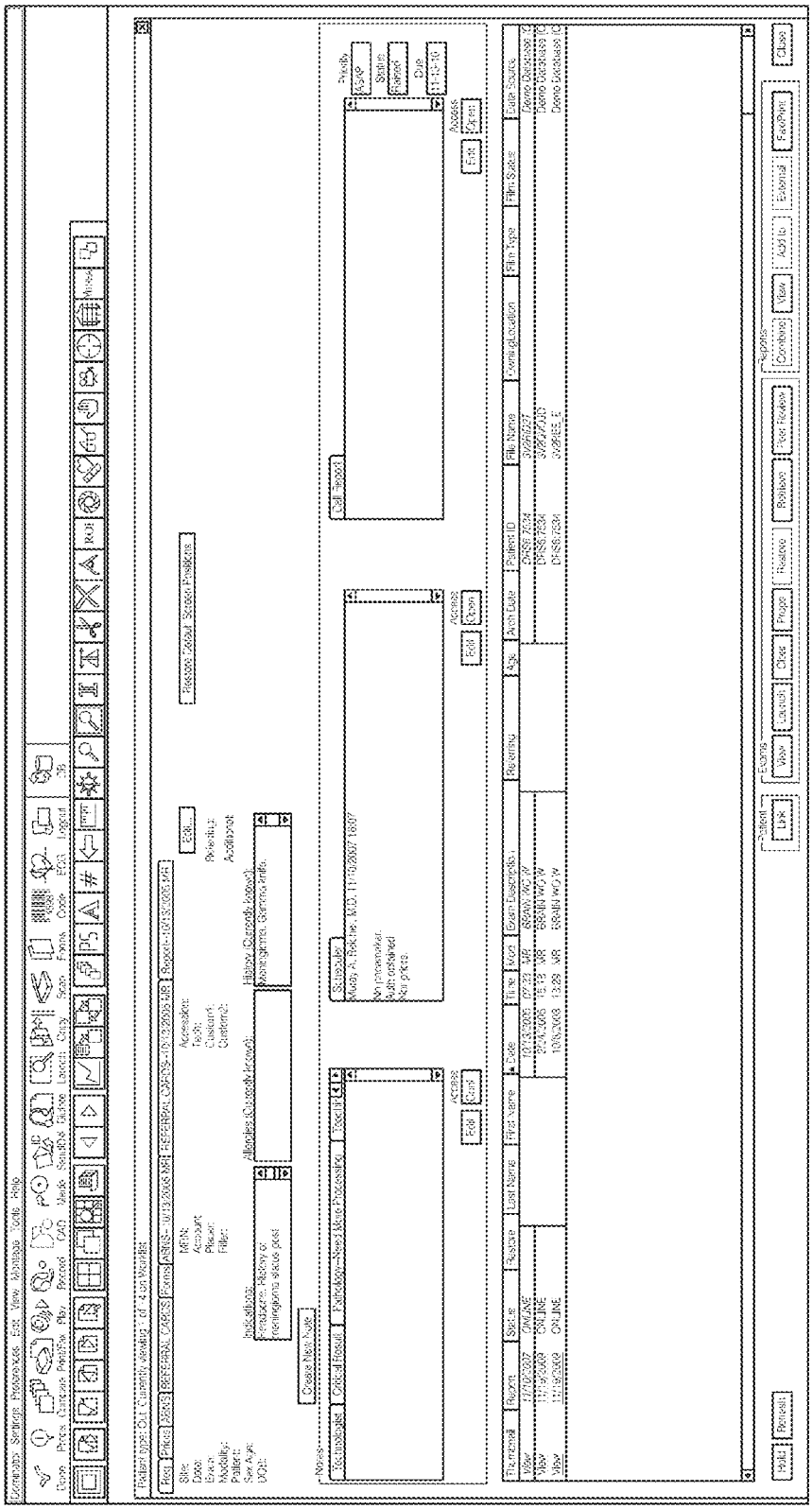


FIG. 3

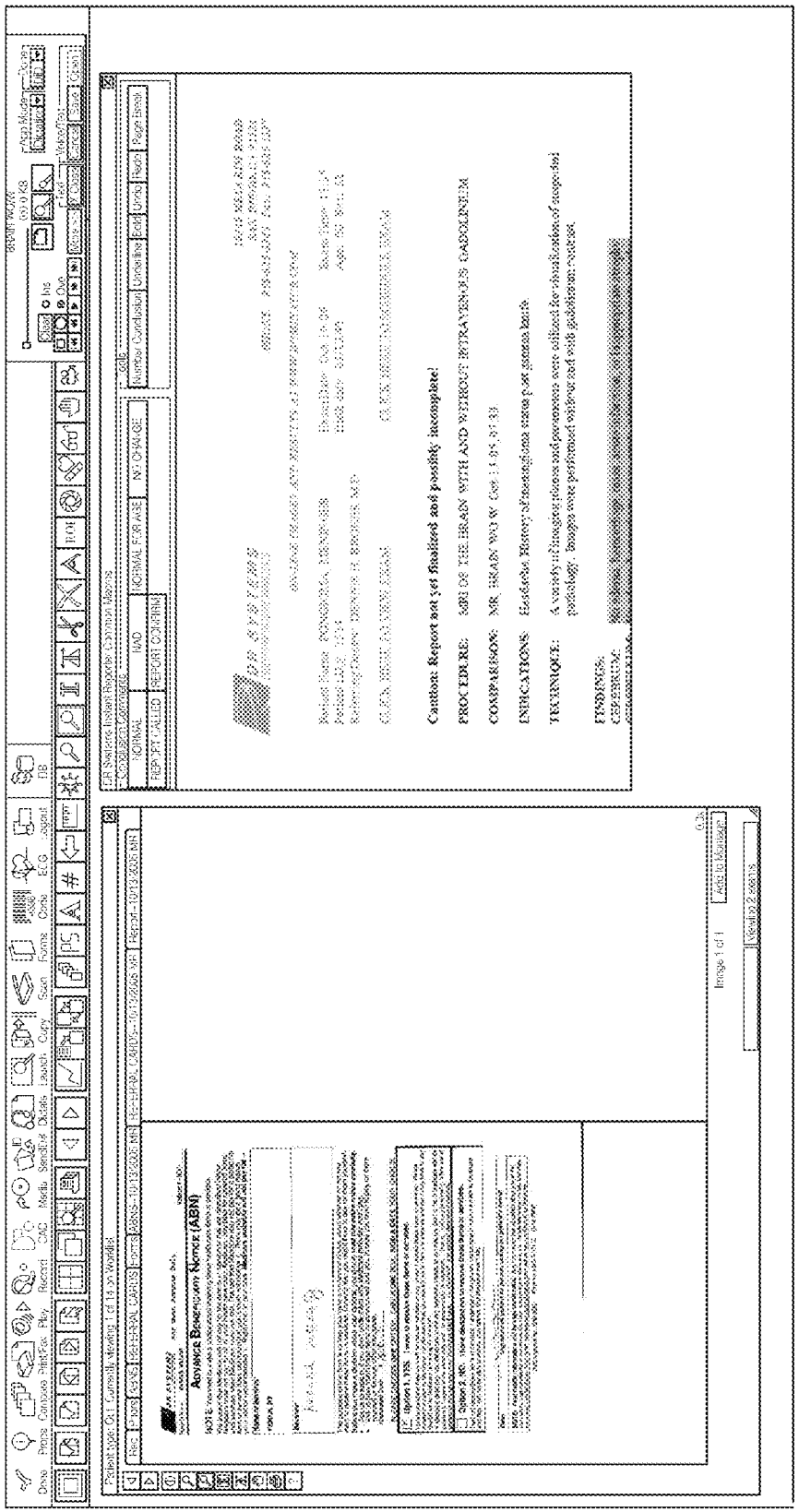
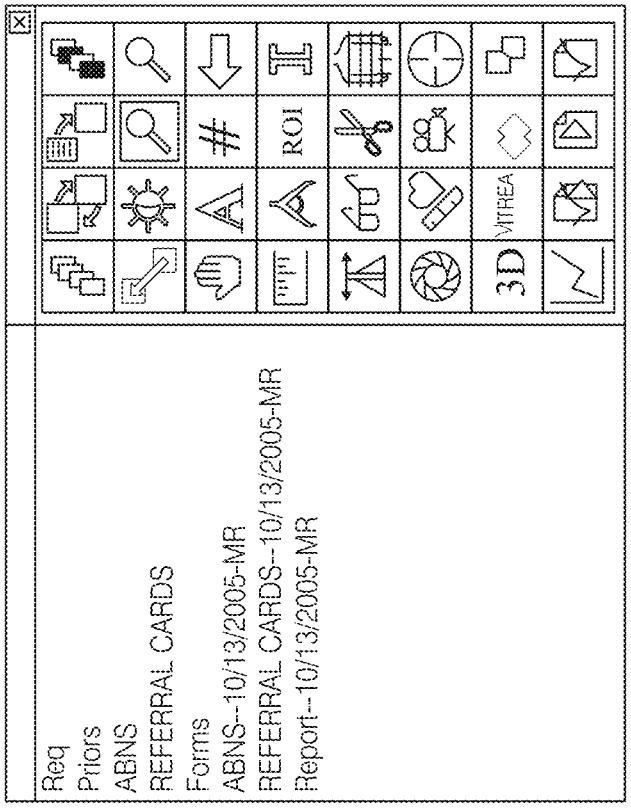


FIG. 4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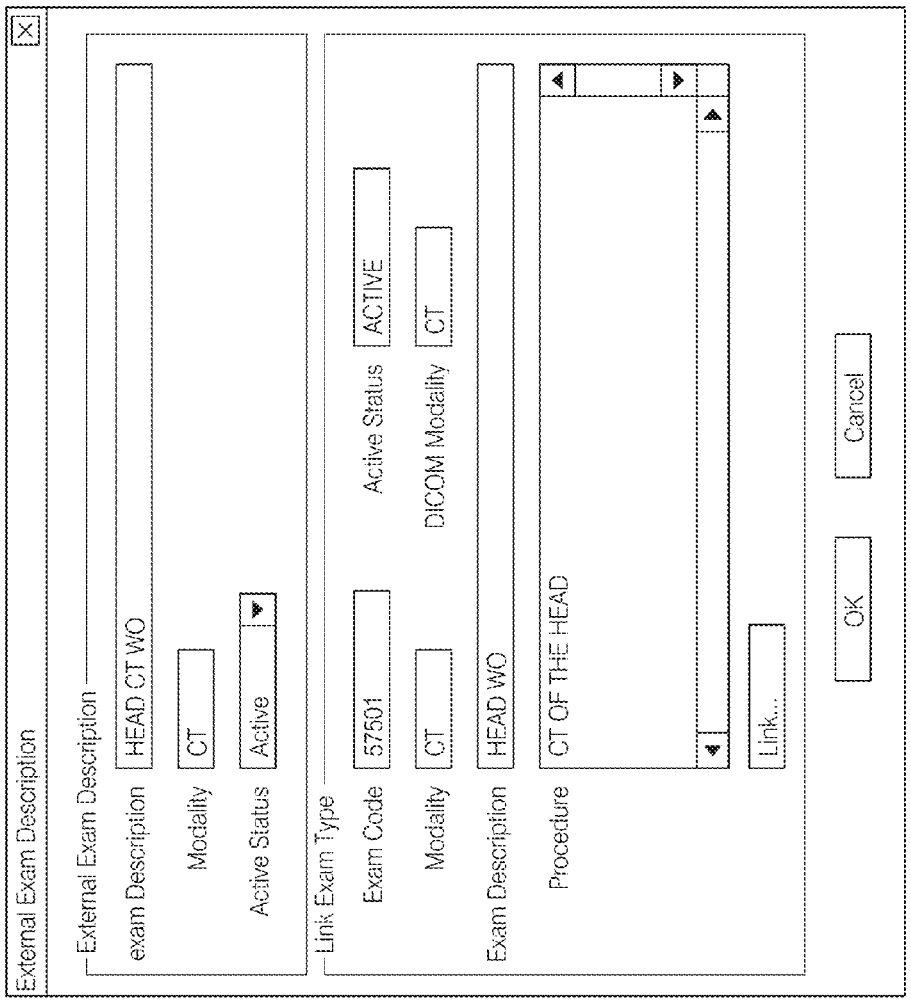
ROI
3D
VITREA

FIG. 5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External Exam Description
exam Description
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CT
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Active
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FIG. 6

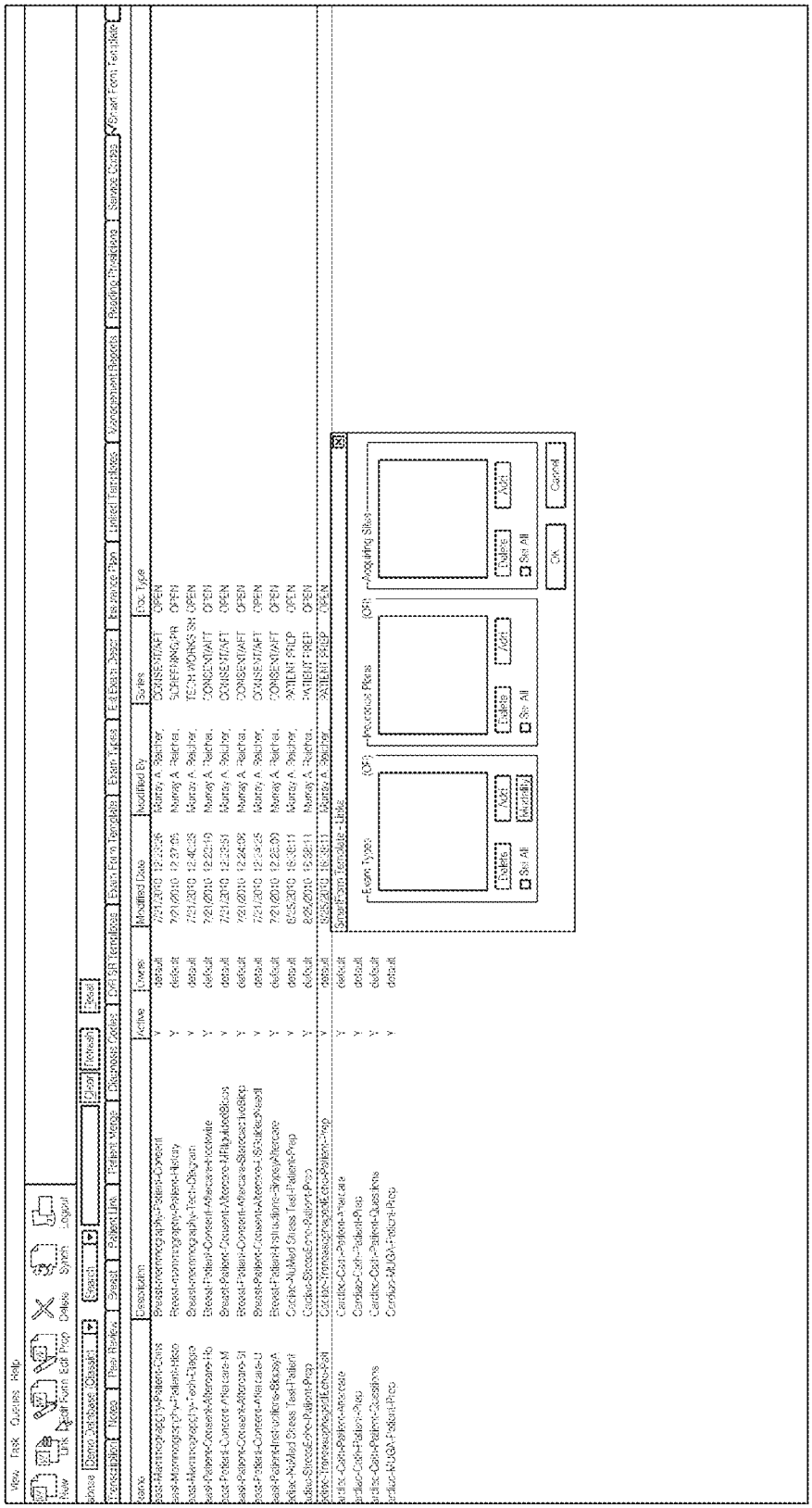


FIG. 7

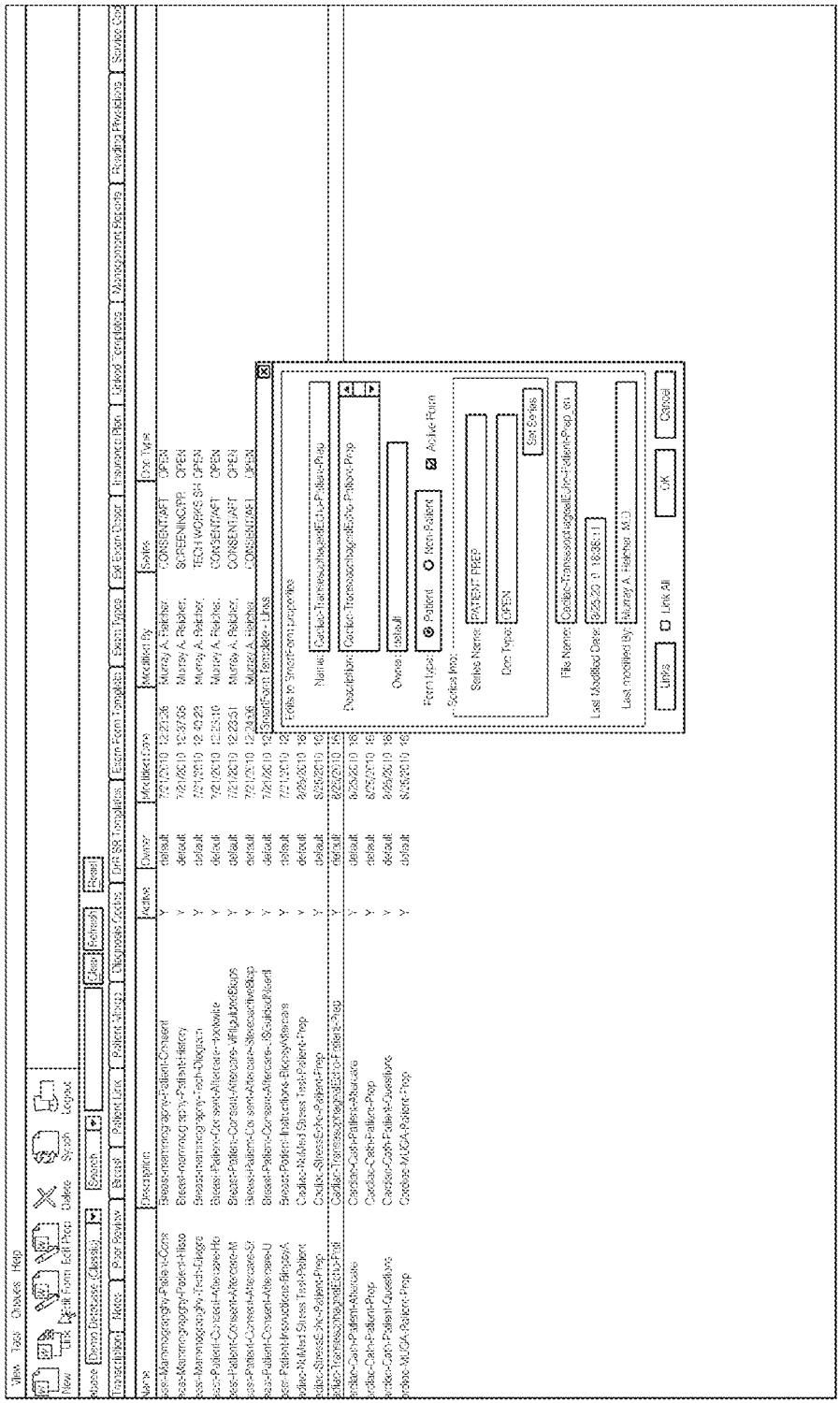
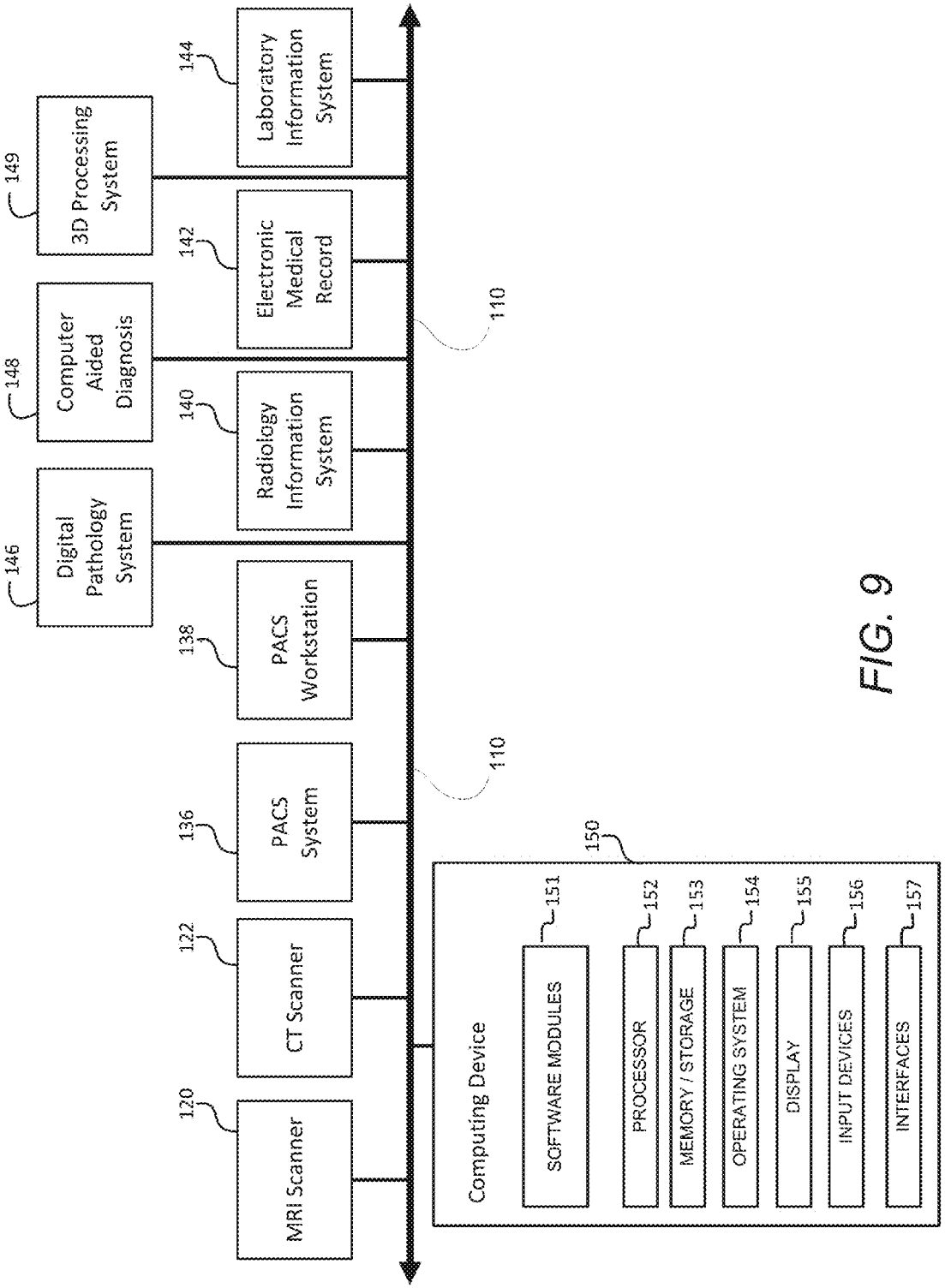


FIG. 8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120
CT Scanner
122
PACS System
136
PACS Workstation
138
Digital Pathology System
146
Computer Aided Diagnosis
148
3D Processing System
149
Radiology Information System
140
Electronic Medical Record
142
Laboratory Information System
144
110
110
Computing Device
150
SOFTWARE MODULES
151
PROCESSOR
152
MEMORY / STORAGE
153
OPERATING SYSTEM
154
DISPLAY
155
INPUT DEVICES
156
INTERFACES
157

FIG. 9

EXAM TYPE MAPPING

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of priority under 35 U.S.C. §119(e) of U.S. Provisional Application No. 61/522,633, filed Aug. 11, 2011, the disclosure of which is hereby incorporated by reference in its entirety.

BACKGROUND

There is a need for innovations that increase the efficiency and accuracy of interpretation of medical imaging exams.

SUMMARY

For purposes of this summary, certain aspects, advantages, and novel features of the invention are described herein. It is to be understood that not necessarily all such advantages may be achieved in accordance with any particular embodiment of the invention. Thus, for example, those skilled in the art will recognize that the invention may be embodied or carried out in a manner that achieves one advantage or group of advantages as taught herein without necessarily achieving other advantages as may be taught or suggested herein.

In one embodiment, a method of matching medical exam types comprises determining an exam type of an exam, accessing, by a computing system having one or more computer processors, an exam type data structure comprising associations between respective master exam types and one or more exam types selectively used by various entities, such that a first master exam type is associated with a first plurality of exam types used by one or more entities and a second master exam type is associated with a second plurality of exam types used by one or more entities, determining whether the determined exam type matches any of the exam types in the exam type data structure, in response to determining that the determined exam type matches one of the first plurality of exam types, associating the exam with the first master exam type so that any rules associated with exams of the first master exam type are automatically selected for use on the exam, and in response to determining that the determined exam type matches one of the second plurality of exam types, associating the exam with the second master exam type so any rules associated with exams of the second master exam type are automatically selected for use on the exam. In one embodiment, the method further comprises updating the exam type of the exam to include the matched master exam type. In one embodiment, the method further comprises replacing the exam type of the exam with the matched master exam type. In one embodiment, the method further comprises, in response to receiving a request for information and/or portion of the exam, replacing the exam type of the exam with the original determined exam type prior to providing the requested information and/or portion of the exam. In one embodiment, the requested information comprises a medical report. In one embodiment, the request is from an entity that associated the exam with the determined exam type. In one embodiment, the rules associated with the first exam type or the second exam type include rules for display, arrangement of various types of items within an exam, transfer, security, or viewing rights, associated with the corresponding exam. In one embodiment, the method further comprises, in response to not matching the determined exam type to any of the exam types in the exam type data structure, prompting a user of the computing system to indicate an association between the determined exam type and one or more exam types in the exam type data structure. In one embodiment, the method further comprises storing the association between the determined exam type and one or more exam types in the exam type data structure provided by the user in the exam type data structure so that the association is usable in automatically updating exam types of other exams having the determined exam type.

In one embodiment, the determined exam type comprises one or more of an exam description associated with the exam and/or a modality of the exam. In one embodiment, the exam description is provided via an HL-7 message that includes text or coded values. In one embodiment, the determined exam type comprises encoded information. In one embodiment, the determined exam type is determined based on data extracted from text or coded values in a data field associated with the images of the exam. In one embodiment, the data field is included in one or more of a cardiovascular information system (CVIS) file, a Digital Imaging and Communications in Medicine (DICOM) file, or a Health Level 7 (HL-7) file associated with the exam.

In one embodiment, the determined exam type matches an exam type in the exam type data structure if the determined exam type and the exam type in the data structure include substantially identical information. In one embodiment, the substantially identical information comprises one or more character strings of the determined exam type and one or more character strings of the matching exam type in the exam type data structure. In one embodiment, the determined exam type is based on one or more of: exam type information, patient demographic information, placer numbers, filler numbers or other coded information.

In one embodiment, the method further comprises applying one or more matching rules to determine whether the determined exam type matches an exam type in the exam type data structure.

In one embodiment, method further comprises determining a confidence level indicating a degree of similarity between the determined exam type and the exam types of the exam type data structure to which the first exam type is compared, wherein the determined exam type matches a respective exam type in response to the confidence level for comparison of the exam type with the respective exam type being above a threshold level. In one embodiment, the threshold level is set based on an organization or user preference.

In one embodiment, the method is performed in response to receiving an exam order including the determined exam type and determining that the determined exam type doesn't match any exam types in the exam type data structure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sample montage that may be displayed on a computing device of a user, such as a radiologist or doctor.

FIG. **2** is another example of a montage with a different number of images, including images that are formatted differently and include annotations (e.g., arrows pointing to areas of specific interest).

FIG. **3** is a sample screen shot of information displayed on a monitor by image viewing/manipulation software, such as DR Systems Unity RIS/PACS.

FIG. **4** is another sample screen shot of information displayed on a monitor including, in this specific example, an Advanced Beneficiary Notice and a clinical report template.

FIG. **5** illustrates a sample toolbox that may be used to select items for display on multiple monitors.

FIG. **6** is a sample user interface that may be displayed to a user when a non-matching exam type is ordered, received, or otherwise accessed.

FIG. **7** illustrates a sample screenshot of a user interface that may be used to link a form with one or more of an exam type, insurance plan, acquisition site, or other link.

FIG. **8** illustrates a sample screenshot of a user interface that allows selection and/or viewing of an attribute indicating whether or not a particular form needs to be returned to the medical facility (e.g., after completion by a patient).

FIG. **9** is a system diagram which shows the various components of a system for performing the system and methods described above.

DETAILED DESCRIPTION

Embodiments of the disclosure will now be described with reference to the accompanying figures, wherein like numerals refer to like elements throughout. The terminology used in the description presented herein is not intended to be interpreted in any limited or restrictive manner, simply because it is being utilized in conjunction with a detailed description of certain specific embodiments of the disclosure. Furthermore, embodiments of the disclosure may include several novel features, no single one of which is solely responsible for its desirable attributes or which is essential to practicing the embodiments of the disclosure herein described.

As used herein, the terms "viewer" and "user" are used interchangeably to describe an individual (or group of individuals) that interfaces with a computing device. Users may include, for example, doctors, radiologists, hospital staff, or other individuals involved in acquisition, analysis, storage, management, or other tasks related to medical images. In other embodiments, users may include any individuals or groups of individuals that generate, transmit, view, and/or otherwise work with images of any type. Any discussion herein of user preferences should be construed to also, or alternatively, include user group preferences, site preferences, system preferences, and/or default software preferences.

Depending on the embodiment, the methods described with reference to the flowcharts, as well as any other methods discussed herein, may include fewer or additional blocks and/or the blocks may be performed in a different order than is illustrated. Software code configured for execution on a computing device in order to perform the methods may be provided on a tangible computer readable medium, such as a compact disc, digital video disc, flash drive, hard drive, memory device or any other tangible medium. Such software code may be stored, partially or fully, on a memory of a computing device (e.g., RAM, ROM, etc.), such as the computing system **150** (see discussion of FIG. **1**, below), and/or other computing devices illustrated in the figures, in order to perform the respective methods. For ease of explanation, the methods will be described herein as performed by the computing system **150**, but the methods are not limited to performance by the computing system **150** and should be interpreted to

include performance by any one or more of the computing devices noted herein and/or any other suitable computing device.

Montage Customizations

FIG. **1** is a sample montage that may be displayed on a computing device of a user, such as a radiologist or doctor. In the illustration of FIG. **1**, the images of the montage are those selected by the reading physician as key images, such as at the time of review of an MRI of the Brain. The exam may include several image series, and hundreds or thousands of images. In one embodiment, the radiologist composes the montage by selecting one or more key images from one or more image series, and by adjusting various view settings of the images, such as window/level settings, centering, cropping, magnification, annotations, insets, etc. The same image might be selected more than once, but shown on the montage with different window/level settings, centering, cropping, magnification, annotations, insets, etc. FIG. **2** is another example of a montage with a different number of images, including images that are formatted differently and include annotations (e.g., arrows pointing to areas of specific interest).

In one embodiment, montages are saved as separate files, such as separate image files that are essentially a screenshot of a montage (e.g., a snapshot of the montages of FIG. **1** or **2**). Thus, the montage that is configured by the viewer (e.g. radiologist or doctor) may be recalled at a later time. In one embodiment, the montage image file may be notated as a key image, such as according to the DICOM (Digital Imaging and Communications in Medicine) specification. The montage might include images from multiple examinations, or might include reference images such as illustrations or medical images exemplifying pathological or normal conditions.

In another embodiment, a montage having 1 or more images can be stored in one or multiple ways, including (1) storage of the complete composite montage image and/or (2) storage of sufficient information regarding each image so that the entire montage can be recreated upon future display or the individually stored images can be displayed, depending on the user's preferences, depending on the display environment (such as aspect ratio of the display window, monitor resolution, a combination of user preferences and display environment, or other factors.) For example, information regarding the arrangement of images in the montage, as well as information regarding display settings of respective images (e.g., magnification, brightness, centering, cropping, filters, annotations, insets, etc.) may be stored. This montage configuration or template information may then be recalled at a future time and used to re-build the montage. In this embodiment, storage of an image of the entire montage may not be necessary.

Additionally, other information related to the montage display/configuration may be stored (and later accessed to rebuild the montage or a montage of different images in the same configuration). For example, information regarding the device on which the montage was generated may be stored. In one embodiment, the resolution of the display device and/or size of a window in which the montage is created (e.g., horizontal pixels by vertical pixels) may be stored. Thus, the system (e.g., the device that will display the images and/or a device that is serving the images) may automatically select the format of the montage (such as 4×2 vs. 2×4) based on the aspect ratio of the images compared to the aspect ratio/orientation of the monitor. In another embodiment, the montage may be displayed in a manually sizable window, and the format of the montage may be automatically and optionally dynamically adjusted based on the aspect ratio of the window. In another embodiment, as images are added to the montage, the display format is automatically adjusted based on the aspect ratio of the montage window, the aspect ratio of the added images, and/or the number of images added.

Similarly, orientation of the display device (e.g., portrait or landscape), as well as matrix information (e.g., the number of rows and columns of images, e.g., 4 images×2 images or 6 images×4 images) may be stored in a montage template. Thus, multiple montage templates that include the same (or some of the same) images may be stored and selected based

on characteristics of the computing device that later displays the montage, such as the display size. Accordingly, a first montage template may be automatically selected for viewing of images of a particular exam on a tablet computer while a second montage template may be automatically selected for viewing of images of the same particular exam on a desktop computer with a monitor having a much higher resolution. The computing device that displays the montage may automatically select the appropriate montage template, without any input from the user.

In one embodiment, the multiple images of a montage are simultaneously saved as key images (e.g., key DICOM objects) so that the images may be easily identified for inclusion in a montage that is generated based on a montage template.

As noted above, montage templates may be automatically selected based on the user, the display monitor (such as its resolution, aspect ratio, Smartphone vs PC monitor, etc), and/or other characteristics of an image viewing environment. Montage templates may be used to display the entire montage in the arrangement originally used by the viewer. In one embodiment, the user may cycle through other images of images series to which key images belong, keeping the same display characteristics as the key image as a default.

In another embodiment, an image may be one of many images in an image series, such as one axial image of a number of stacked axial images of the patient. In this case, in one embodiment, when an image is added to the montage the system may retain information related to the entire series of images so that a user may manipulate the montage image to also access other images in the same series.

By saving the key object information, a user can preserve the ability to manipulate each image individually, even when the images are displayed in the grouped montage mode.

Customized Display of Documents/Dialogs

FIG. **3** is a sample screen shot of information displayed on a monitor by image viewing/manipulation software, such as DR Systems Unity RIS/PACS. The large dialog that fills most of the screen may be referred to as the Requisition, and it contains several tabs, some shown in red (the last three tabs) and others in blue (the first five tabs). Each tab represents a document or dialog associated with one or more imaging exams that are currently displayed on other monitors of a multi-monitor system. For example, FIG. **4** is a sample screen shot of one such arrangement, where the clinical report template associated with the current exam is displayed on the right, and a scanned document (Advanced Beneficiary Notice) is shown on the left.

In some scenarios, a reading physician may want to display the Requisition and the various available documents/dialogs/webforms according to a preferred layout (e.g., a user-preferred layout), including size and position of various available elements. For example, with reference to FIG. **4**, the user may have displayed the Advanced Beneficiary Notice by selecting one of the tabs from the upper left of the requisition, via another mouse action, keyboard shortcut or audio command, and also displayed the clinical report template through another means, such as a button click, mouse click, hotkey, or audio command. After selecting documents/dialogs for display, the user can adjust the size and position of these objects. Repeating these actions for other patients/exams is repetitive and not efficient. There can be many tabs available on the requisition or elsewhere for display of various categories of display objects, such as clinical reports, scanned documents, photographs, forms, prior exam lists etc.

In one advantageous embodiment, when a user sizes and positions a window, the system remembers that size and position for that category of object and for the user (or user group). The system may then automatically recreate that sizing and layout in the future for that user when a document of the category is displayed. Accordingly, each user can size and position these various documents/dialogs, and the system will remember the layout for any workstation across the network that uses a monitor of the same matrix size, while defaulting to a standard configuration for monitors of a different matrix size. In one embodiment, a single user may have multiple arrangements of documents/dialogs that are associated with different monitor sizes that are used by the user. In some embodiment, display settings may be stored for specific documents/dialogs as well, or as an alternative to the category settings discussed above.

In one embodiment, the display characteristics are associated with a display size (e.g., the matrix size and/or orientation of a monitor on which the document/dialog was viewed), such that the sizing and layout of documents of that category are displayed in that manner only when requested for viewing on the same or similar display configuration. In this embodiment, the system may select a default display layout for other monitor formats. If the user then sets the sizing and layout for another monitor format, the system will remember both set-ups for the user and make those layouts available to other devices throughout a network, such as a WAN or LAN. Any number of set-ups can be remembered.

In one embodiment, the user can open a toolbox, such as the sample toolbox of FIG. **5**, from any of multiple monitors by clicking a keyboard shortcut or mouse button, or via an audio command. This toolbox includes a list of all of the display objects available on the Requisition or other objects. The user can select any item on the list to immediately display the desired object, and the object will appear in the location associated with the users stored display layout preference or the default layout preference. Thus, the user does not need to drag a mouse to the monitor on which he wants to display the object, and one can control the display of an object on one monitor or in one display window, while working from another monitor or another display window. For example, a single monitor may be large enough to display many windows that might have previously required many monitors. In such an embodiment, the systems and methods discussed herein allow automatic positioning on the single monitor at a location associated with the user account. A reading physician who is viewing images on another monitor (or in another window of a same monitor) can thus control the display of objects on a first monitor without first dragging a mouse or distracting his vision to the first monitor. When the object appears, it follows the stored set-up instructions.

Exam Description Mapping

RIS, PACS, and other healthcare information systems typically contain a table of Exam Types, which is a list of various medical imaging exams available for selection. The Exam Type data structure (or "Exam type master file" or "Exam Type table") may include exam descriptions, modality descriptions, alphanumeric codes, as well as other information about each Exam Type—such as the default title of a clinical report based on that Exam Type, forms that should appear to the user (clerk, patient, technologist, and/or doctor) when that Exam Type is performed or viewed, linked clinical report templates, linked information about required supplies, clinical protocols, payment policies, charges, relative value/productivity units, safety policies and more. In addition, various user or site preferences can be based on the Exam Type or modality, such as which exams should be automatically restored from archive for comparison when a particular Exam Type is scheduled or performed, which and how many exams

are displayed for comparison when an exam is viewed, how a particular user prefers images to be displayed, and more. In addition, system automation may depend on the Exam Type data structure, such as rules automating the pre-fetching of prior comparison exams, reading physician protocols for exam display, automated creation of virtual series, keyboard shortcuts, reading sequences, routing of exams, and more. Therefore, in a sense, the Exam Type master file is a sort of DNA of some healthcare information system.

When a RIS/PACS or other related information system receives medical images or orders from external system, the Exam Type information may or may not match up with information already present in the Exam Type table. For example, exams of the same type may be named differently by different acquisition/viewing system. This information might be exchanged via information in a DR RIS, CVIS, DICOM metafile, in an HL-7 message, an order message, billing message, etc. In one embodiment, the system may offer configuration options that specify how the system should respond to a non-matching Exam Type, such as by either holding the processing of the message or exam import, or automatically adding the non-matching Exam Type to the Exam Type master file. However, either of these options prevents automated performance of actions that are customized for a particular exam type due to a non-matching Exam Type. In fact, setting up actions for a non-matching Exam Type often requires manual intervention. Alternatively, automatically adding a non-matching Exam Type to the Exam Type master file may disrupt automated steps that are dependent on a precisely linked and set-up list of Exam Types.

In order to make more efficient use of the Exam Type master file, in one embodiment an Exam Type mapping function is defined so that when a non-matching Exam Type is encountered by the system via the variety of different possible messages described above, the system prompts the user (in one or more of many possible manners—such as either a pop-up message, generation of a worklist, text-message of other means) that a non-matching Exam Type was encountered. The user can then map the non-matching Exam Type to the proper Exam Type from the master file, so that if the non-matching Exam Type is again encountered, it can be automatically processed (e.g., without any notification to the user). As a result, and depending on the type of in-bound message, the system might create a new scheduled exam with the internally mapped Exam Type, or import a DICOM imaging exam with the proper internally mapped Exam Type. All of the system automation that depends on the internally mapped Exam Type may then properly occur.

FIG. **6** is a sample user interface that may be displayed to a user when a non-matching Exam Type is ordered or received. In this embodiment, the Exam Description may be mapped to an Exam Type already stored in the Exam Type master file so that future exams having the same Exam Description are automatically mapped to the selected Exam Type and its corresponding actions.

In one embodiment, in addition to providing the ability to manually map Exam Types as discussed above, the system could apply rules that map Exam Types based on relative matching of character strings or other best match rules related to Exam Codes or other message characteristics. Based on a confidence level of a match, the automated mapping may be applied without further input from the user. For example, if a confidence level of a match is lower (e.g., below 80%) the user may be provided with the most likely matches and provided an opportunity to select from the short list of possible matches, rather than navigating through a list of all Exam Types in the master file.

In one embodiment, this mapping may be applied not only to inbound messages/exams, but also to outbound messages returning to external information systems, so that any edits, changes, and/or updates could be communicated back to the original system. For example, in one embodiment the exam type of an incoming exam may be changed to a master exam type from the exam type data structure, e.g., so that rules associated with the master exam type may be applied to the incoming exam. When the exam is transmitted elsewhere, such as back to the providing entity, the master exam type may not be recognized by the providing entity. Accordingly, in one embodiment, the exam type is reverted to the original exam time that was included in the recently received exam.

Depending on the embodiment, the exam type may include part or all of an exam description field, a coded value that references an exam type, an imaging modality, any other information, or combinations of information, associated with the exam.

In one embodiment, when an exam order is received via HL-7 or some other electronic interface, if the exam type that is ordered does not match the exam type data structure, the user is prompted to provide a mapping between the received exam type and one of the exam types in the exam type data structure. The provided mapping may then be stored for future automated linking when the exam type is received again in the future. Additionally, for a specific exam, if the exam type is linked or replaced, the system can remember the link and any associated data (such as the filler/placer or other values), and return that information to external systems (e.g., the original provider of the exam) along with any other data associated with the exam (e.g., a report associated with the exam).

Automated Forms to Patient Portal

Patient forms may be created and stored as form templates that are referred to in a data structure that links respective form templates with various links. The links can indicate when the forms are automatically presented and where they are automatically filed. For example, a particular form might be linked to a particular insurance, patient sex, patient language, age group, exam type, modality, or other stored information. As a result, when a scheduled exam is selected, the proper forms for that patient can be automatically presented for printing or electronic completion. In addition, the form templates can be linked to a specific naming convention and storage location. For example, one might create a CT Consent Form template and an MRI Consent Form template, and store information such that when either of these templates is used to create a CT Consent Form or MRI Consent Form, these forms are stored with the patient record such that they are labeled as Consent Forms, whereas there might be other form templates that would be stored as Insurance Forms, or Release Forms, etc.

In one embodiment, when an exam is scheduled, the proper forms based on the automated links are posted to an internet-accessible location where the proper patient can view, print, or complete the forms. The forms may be automatically labeled with an identifying barcode, so that if the patient prints and completes the forms on paper, the paper can later be scanned, the bar code identified, and the form thus automatically filed with the proper patient, proper exam, and proper label. Each instance of a form may be provided with a specific identifier so that the information provided in the form (e.g., electronically or manually) may be associated with the proper patient's record and/or exam, and labeled properly. FIG. **7** illustrates a sample screenshot of a user interface that may be used to link a form with one or more of an Exam Type, Insurance Plan, Acquisition Site, or other link.

FIG. **8** is a screenshot of a sample user interface that may be accessible by a "Set Series" or similar button. The user interface allows the user to specify the category or series name that will be used to store instances of the form that are created using one of the templates stored in this list. Note that the templates might be one of many types of document formats, including MSWord, HTML, XML, CDA, CCR, etc. By placing a barcode on a printed form or by associating information with an electronic form, the system can automatically store the instance of the form with the proper patient, proper exam, and in the proper series. The series information may also further specify if, how, and when the form is presented for any particular user or by system default.

In one embodiment, forms may be associated with an attribute that indicates whether the form must be returned to system (e.g., to the medical facility that originally provided the form). Depending on various factors (e.g., reasons for visiting a medical facility), some quantity of forms provided to a patient may be for use of the patient (and/or a party other than the medical facility that provides the forms) and, thus, are not required to be returned to the medical facility. For example, a medical facility may not want forms that provide informational content to the patient returned to the medical facility. However, many forms provided to the patient may need to be returned to the medical facility and/or required to be returned prior to performance of an exam or procedure, for example. Thus, an attribute indicating whether or not a particular form needs to be returned to the medical facility may be indicated using a user interface similar to that shown in FIG. **8**. A patient's file may then be automatically reviewed in order to determine if any forms that are required to be returned have not yet been returned (possibly a certain number of days after the forms are provided or a certain number of days before a scheduled exam).

Example System Implementation

FIG. **9** is a system diagram which shows the various components of a system **100** for performing the system and methods described above, wherein the configuration of the system **100** may include fewer or additional features than are illustrated and individual components, such as the computing device **150**, may also include fewer or additional components. In one embodiment the methods discussed above as being performed by "a system" are performed by the computing device **150**. In other embodiments, the methods may be performed by any other suitable computing device.

The Computing Device **150** may take various forms. In one embodiment, the Computing Device **150** may be a computer workstation having software modules **151**. In other embodiments, software modules **151** may reside on another computing device, such as a web server, and the user directly interacts with a second computing device that is connected to the web server via a computer network.

In one embodiment, the Computing Device **150** comprises a server, a desktop computer, a workstation, a laptop computer, a mobile computer, a Smartphone, a tablet computer, a cell phone, a personal digital assistant, a gaming system, a kiosk, an audio player, any other device that utilizes a graphical user interface, including office equipment, automobiles, airplane cockpits, household appliances, automated teller machines, self-service checkouts at stores, information and other kiosks, ticketing kiosks, vending machines, industrial equipment, and/or a television, for example.

The Computing Device **150** runs an operating system **154**, such as an off-the-shelf operating system, for example, Windows, Linux, MacOS, Android, or iOS operation system. The Computing Device **150** may also run a more specialized operating system which may be designed for the specific tasks performed by the computing device **150**.

The Computing Device **150** may include one or more computing processors **152**. The computer processors **152** may include central processing units (CPUs), and may further include dedicated processors such as graphics processor chips, or other specialized processors. The processors generally are used to execute computer instructions based on the software modules **151** to cause the computing device to perform operations as specified by the modules **151**. The modules **151** may include, by way of example, components, such as software components, object-oriented software components, class components and task components, processes, functions, attributes, procedures, subroutines, segments of program code, drivers, firmware, microcode, circuitry, data, data structures, data structures, tables, arrays, and variables. For example, modules may include software code written in a programming language, such as, for example, Java, JavaScript, ActionScript, Visual Basic, HTML, C, C++, or C#. While "modules" are generally discussed herein with reference to software, any modules may alternatively be represented in hardware or firmware. Generally, the modules described herein refer to logical modules that may be combined with other modules or divided into sub-modules despite their physical organization or storage.

The Computing Device **150** may also include memory **153**. The memory **153** may include volatile data storage such as RAM or SDRAM. The memory **153** may also include more permanent forms of storage such as a hard disk drive, a flash disk, flash memory, a solid state drive, or some other type of non-volatile storage.

The Computing Device **150** may also include or be interfaced to one or more display devices **155** that provide information to the users. Display devices **155** may include a video display, such as one or more high-resolution computer monitors, or a display device integrated into or attached to a laptop computer, handheld computer, Smartphone, computer tablet device, or medical scanner. In other embodiments, the display device **155** may include an LCD, OLED, or other thin screen display surface, a monitor, television, projector, a display integrated into wearable glasses, or any other device that visually depicts user interfaces and data to viewers.

The Display Computing Device **150** may also include or be interfaced to one or more input devices **156** which receive input from users, such as a keyboard, trackball, mouse, 3D mouse, drawing tablet, joystick, game controller, touch screen (e.g., capacitive or resistive touch screen), touchpad, accelerometer, video camera and/or microphone.

The Computing Device **150** may also include one or more interfaces **157** which allow information exchange between Computing Device **150** and other computers and input/output devices using systems such as Ethernet, Wi-Fi, Bluetooth, as well as other wired and wireless data communications techniques.

The modules of Computing Device **150** may be connected using a standard based bus system. In different embodiments, the standard based bus system could be Peripheral Component Interconnect ("PCI"), PCI Express, Accelerated Graphics Port ("AGP"), Micro channel, Small Computer System Interface ("SCSI"), Industrial Standard Architecture ("ISA") and Extended ISA ("EISA") architectures, for example. In addition, the functionality provided for in the components and modules of Computing Device **150** may be combined into fewer components and modules or further separated into additional components and modules.

Computing Device **150** may communicate and/or interface with other systems and/or devices. In one or more embodiments, the computing device **150** may be connected to a computer network **110**.

The computer network **110** may take various forms. It may be a wired network or a wireless network, or it may be some combination of both. The computer network **110** may be a single computer network, or it may be a combination or collection of different networks and network protocols. For example, the computer network **110** may include one or more local area networks (LAN), wide area networks (WAN), personal area networks (PAN), cellular or data networks, and/or the Internet.

Various devices and subsystems may be connected to the network **110**. For example, one or more medical scanners may be connected, such as MRI scanners **120**. The MRI scanners **120** may be used to acquire MRI images from patients, and may share the acquired images with other devices on the network **110**. The network **110** may also be coupled to one or more CT scanners **122**. The CT scanners **122** may also be used to acquire images and, like the MRI scanner **120**, may then store those images and/or share those images with other devices via the network **110**. Any other scanner or device capable of inputting or generating information could be included, including ultrasound, angiography, nuclear medicine, radiography, endoscopy, pathology, dermatology, etc.

Also connected to the network **110** may be a Picture Archiving and Communications System (PACS) **136** and PACS workstation **138**. The PACS **136** is typically used for the storage, retrieval, distribution and presentation of images (such as those created and/or generated by the MRI scanner **120** and CT Scanner **122**). The medical images may be stored in an independent format, an open source format, or some other proprietary format. A common format for image storage in the PACS system is the Digital Imaging and Communications in Medicine (DICOM) format. The stored images may be transmitted digitally via the PACS system, often reducing or eliminating the need for manually creating, filing, or transporting film jackets.

The network **110** may also be connected to a Radiology Information System (RIS) **140**. The radiology information system **140** is typically a computerized data storage system that is used by radiology departments to store, manipulate and distribute patient radiological information such as Radiology Reports.

Also attached to the network **110** may be an Electronic Medical Record (EMR) system **142**. The EMR system **142** may be configured to store and make accessible to a plurality of medical practitioners computerized medical records. Also attached to the network **110** may be a Laboratory Information System **144**. Laboratory Information System **144** is typically a system which stores information created or generated by clinical laboratories. Also attached to the network **110** may be a Digital Pathology System **146** used to digitally manage and store information related to medical pathology.

Also attached to the network **110** may be a Computer Aided Diagnosis System (CAD) **148** used to analyze images. In one embodiment, the CAD **148** functionality may reside in a computing device separate from Information Display Computing Device **150** while in another embodiment the CAD **148** functionality may reside within Information Display Computing Device **150**.

Also attached to the network **110** may be a 3D Processing System **149** used to perform computations on imaging information to create new views of the information, e.g., 3D volumetric display, Multiplanar Reconstruction (MPR) and Maximum Intensity Projection reconstruction (MIP). In one embodiment, the 3D Processing functionality may reside in a computing device separate from Information Display Computing Device **150** while in another embodiment the 3D Processing functionality may reside within Information Display Computing Device **150**.

In other embodiments, other computing devices that store, provide, acquire, and/or otherwise manipulate medical data may also be coupled to the network **110** and may be in communication with one or more of the devices illustrated in FIG. **9**, such as with the Information Display Computing Device **150**.

As will be discussed herein, Computing Device **150** may be configured to interface with various networked computing devices in order to communicate medical information that is stored among the various systems present in the network. In other embodiments, Information Display Computing Device **150** may be used to display non-medical information.

Depending on the embodiment, the other devices illustrated in FIG. **9** may include some or all of the same components discussed above with reference to the Information Display Computer Device **150**.

SUMMARY

Conditional language, such as, among others, "can," "could," "might," or "may," unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments include, while other embodiments do not include, certain features, elements and/or steps. Thus, such conditional language is not generally intended to imply that features, elements and/or steps are in any way required for one or more embodiments or that one or more embodiments necessarily include logic for deciding, with or without user input or prompting, whether these features, elements and/or steps are included or are to be performed in any particular embodiment.

Any process descriptions, elements, or blocks in the flow diagrams described herein and/or depicted in the attached figures should be understood as potentially representing modules, segments, or portions of code which include one or more executable instructions for implementing specific logical functions or steps in the process. Alternate implementations are included within the scope of the embodiments described herein in which elements or functions may be deleted, executed out of order from that shown or discussed, including substantially concurrently or in reverse order, depending on the functionality involved, as would be understood by those skilled in the art.

All of the methods and processes described above may be embodied in, and partially or fully automated via, software code modules executed by one or more general purpose computers. For example, the methods described herein may be performed by an Information Display Computing Device and/or any other suitable computing device. The methods may be executed on the computing devices in response to execution of software instructions or other executable code read from a tangible computer readable medium. A tangible computer readable medium is a data storage device that can store data that is readable by a computer system. Examples of computer readable mediums include read-only memory, random-access memory, other volatile or non-volatile memory devices, CD-ROMs, magnetic tape, flash drives, and optical data storage devices.

It should be emphasized that many variations and modifications may be made to the above-described embodiments,

the elements of which are to be understood as being among other acceptable examples. All such modifications and variations are intended to be included herein within the scope of this disclosure. The foregoing description details certain embodiments of the invention. It will be appreciated, however, that no matter how detailed the foregoing appears in text, the invention can be practiced in many ways. As is also stated above, it should be noted that the use of particular terminology when describing certain features or aspects of the invention should not be taken to imply that the terminology is being re-defined herein to be restricted to including any specific characteristics of the features or aspects of the invention with which that terminology is associated. The scope of the invention should therefore be construed in accordance with the appended claims and any equivalents thereof.

What is claimed is:

1. A method of matching medical exam types, the method comprising:

receiving, from an external computing device operated by a third party, electronic medical data of an exam associated with a particular patient;

accessing, by a computing system having one or more computer processors, an exam type data structure, the exam type data structure storing associations between a list of master exam types and a list of received exam types;

determining, by automated analysis of the electronic medical data by the computing system, an exam type of the received exam;

determining, by the computing system, whether the determined exam type of the received exam matches any of the received exam types in the exam type data structure;

in response to determining that the determined exam type of the received exam is associated with only one master exam type in the exam type data structure:

associating, by the computing system, the received exam with the only one master exam type; and

executing, by the computing system, one or more rules associated with the only one master exam type on the received exam; and

in response to determining that the determined exam type of the received exam is not associated with any of the master exam types in the exam type data structure:

determining, by automated analysis of the electronic medical data by the computing system, one of the master exam types that most closely matches the received exam type of the received exam;

determining, by the computing system, a measure of confidence that the one of the master exam types corresponds to the received exam type of the received exam; and

in response to determining, by the computing system, that the measure of confidence satisfies a predetermined threshold:

associating, by the computing system, the received exam type of the received exam with the one of the master exam types;

associating, by the computing system, the received exam with the one of the master exam types; and

executing, by the computing system, one or more rules associated with the one of the master exam types on the received exam.

2. The method of claim **1**, further comprising:

further in response to determining that the determined exam type of the received exam is associated with only one master exam type in the exam type data structure:

replacing the determined exam type of the received exam with the only one master exam type.

3. The method of claim **2**, further comprising:

in response to receiving, from another external computing device operated by another third party, a request for information and/or portion of the received exam, replacing an exam type of the received exam with the determined exam type of the received exam prior to providing the requested information and/or portion of the received exam.

4. The method of claim **3**, wherein the another third party is the third party.

5. The method of claim **1**, wherein the one or more rules associated with the only one master exam type or the one of the master exam types includes at least one of: rules for display, rules for arrangement of various types of items within an exam, rules for transfer, rules for security, or rules for viewing rights.

6. The method of claim **1**, further comprising:

in response to not matching the determined exam type of the received exam to any of the master exam types in the exam type data structure, prompting, by the computing system, a user of the computing system to indicate an association between the determined exam type of the received exam and one or more master exam types in the exam type data structure.

7. The method of claim **6**, further comprising:

storing, by the computing system, the association between the determined exam type of the received exam and the one or more master exam types in the exam type data structure provided by the user in the exam type data structure so that the association is usable in automatically updating exam types of other exams having the determined exam type.

8. The method of claim **1**, wherein the determined exam type of the received exam comprises one or more of: an exam description associated with the received exam, or a modality of the received exam.

9. The method of claim **8**, wherein the exam description is provided via an HL-7 message that includes text or coded values.

10. The method of claim **1**, wherein the determined exam type of the received exam comprises encoded information.

11. The method of claim **1**, wherein the determined exam type of the received exam is determined based on data extracted from text or coded values in a data field associated with images of the received exam.

12. The method of claim **11**, wherein the data field is included in one or more of: a cardiovascular information system (CVIS) file, a Digital Imaging and Communications in Medicine (DICOM) file, or a Health Level 7 (HL-7) file associated with the exam.

13. The method of claim **1**, wherein the determined exam type of the received exam matches a master exam type in the exam type data structure if the determined exam type of the received exam and the master exam type in the data structure include substantially identical information.

14. The method of claim **13**, wherein the substantially identical information comprises one or more character strings of the determined exam type of the received exam and one or more character strings of the matching master exam type in the exam type data structure.

15. The method of claim **1**, wherein determining, by the computing system, whether the determined exam type of the received exam matches any of the received exam types in the exam type data structure comprises:

applying, by the computing system, one or more matching rules to determine whether the determined exam type of the received exam matches a master exam type in the exam type data structure.

16. The method of claim **1**, wherein the predetermined threshold is set based on an organization or user preference.

17. The method of claim **3**, wherein the requested information comprises a medical report.

18. The method of claim **1**, wherein the determined exam type of the received exam is comprises one or more of: exam type information, patient demographic information, placer numbers, filler numbers, or other coded information.

19. The method of claim **1**, wherein the method is performed in response to receiving an exam order including the determined exam type and determining that the determined exam type doesn't match any exam types in the exam type data structure.

20. The method of claim **1** further comprising:

augmenting, by the computing system, the electronic medical data with data associated with the patient and stored in the computing system;

preparing, by the computing system, to transmit the augmented electronic medical data to another external computing device operated by another third party by:

determining, by reference to the exam type data structure and by the computing system, a received exam type associated with the another third party and corresponding to the matching master exam type or the one of the master exam types; and

associating, by the computing system, the determined received exam type with the augmented electronic medical data; and

transmitting, by the computing system, the augmented electronic medical data to the another external computing device operated by the another third party.

21. The method of claim **1** further comprising:

in response to determining, by the computing system, that the measure of confidence does not satisfy the predetermined threshold:

determining, by automated analysis of the electronic medical data by the computing system, at least one additional of the master exam types that closely matches the received exam type of the received exam after the one of the master exam types;

prompting, by the computing system, a user of the computing system to select a matching master exam type from the group consisting of: the one of the master exam types, and the at least one additional of the master exam types;

associating, by the computing system, the received exam type of the received exam with the selected matching master exam type;

associating, by the computing system, the received exam with the selected matching master exam type; and

executing, by the computing system, one or more rules associated with the selected matching master exam type on the received exam.

22. A non-transitory computer readable storage medium storing computer-executable instructions configured for execution by one or more hardware processors of a computer system to cause the computer system to:

receive, from an external computing device operated by a third party, electronic medical data of an exam associated with a particular patient;

access an exam type data structure, the exam type data structure storing associations between a list of master exam types and a list of received exam types;

determine, by automated analysis of the electronic medical data, an exam type of the received exam;

determine whether the determined exam type of the received exam matches any of the received exam types in the exam type data structure;

in response to determining that the determined exam type of the received exam is associated with only one master exam type in the exam type data structure:

associate the received exam with the only one master exam type; and

execute one or more rules associated with the only one master exam type on the received exam; and

in response to determining that the determined exam type of the received exam is not associated with any of the master exam types in the exam type data structure:

determine, by automated analysis of the electronic medical data, one of the master exam types that most closely matches the received exam type of the received exam;

determine a measure of confidence that the one of the master exam types corresponds to the received exam type of the received exam; and

in response to determining that the measure of confidence satisfies a predetermined threshold:

associate the received exam type of the received exam with the one of the master exam types;

associate the received exam with the one of the master exam types; and

execute one or more rules associated with the one of the master exam types on the received exam.

23. The non-transitory computer readable storage medium of claim **22**, wherein the computer-executable instructions are configured for execution by one or more hardware processors of a computer system to further cause the computer system to:

augment the electronic medical data with data associated with the patient and stored in the computing system;

prepare to transmit the augmented electronic medical data to another external computing device operated by another third party by:

determine, by reference to the exam type data structure, a received exam type associated with the another third party and corresponding to the matching master exam type or the one of the master exam types; and

associate the determined received exam type with the augmented electronic medical data; and

transmit the augmented electronic medical data to the another external computing device operated by the another third party.

24. The non-transitory computer readable storage medium of claim **22**, wherein the computer-executable instructions are configured for execution by one or more hardware processors of a computer system to further cause the computer system to:

in response to determining that the measure of confidence does not satisfy the predetermined threshold:

determine, by automated analysis of the electronic medical data, at least one additional of the master exam types that closely matches the received exam type of the received exam after the one of the master exam types;

prompt a user of the computing system to select a matching master exam type from the group consisting of: the one of the master exam types, and the at least one additional of the master exam types;

associate the received exam type of the received exam with the selected matching master exam type;

associate the received exam with the selected matching master exam type; and

execute one or more rules associated with the selected matching master exam type on the received exam.

25. A computing system comprising:

one or more storage devices configured to store electronic software instructions; and

one or more computer processors in communication with the one or more storage devices and configured to execute the stored electronic software instructions to cause the computing system to:

receive, from an external computing device operated by a third party, electronic medical data of an exam associated with a particular patient;

access an exam type data structure, the exam type data structure storing associations between a list of master exam types and a list of received exam types;

determine, by automated analysis of the electronic medical data, an exam type of the received exam;

determine whether the determined exam type of the received exam matches any of the received exam types in the exam type data structure;

in response to determining that the determined exam type of the received exam is associated with only one master exam type in the exam type data structure:

associate the received exam with the only one master exam type; and

execute one or more rules associated with the only one master exam type on the received exam; and

in response to determining that the determined exam type of the received exam is not associated with any of the master exam types in the exam type data structure:

determine, by automated analysis of the electronic medical data, one of the master exam types that most closely matches the received exam type of the received exam;

determine a measure of confidence that the one of the master exam types corresponds to the received exam type of the received exam; and

in response to determining that the measure of confidence satisfies a predetermined threshold:

associate the received exam type of the received exam with the one of the master exam types;

associate the received exam with the one of the master exam types; and

execute one or more rules associated with the one of the master exam types on the received exam.

26. The computing system of claim **25**, wherein the one or more computer processors are configured to execute the stored electronic software instructions to further cause the computing system to:

augment the electronic medical data with data associated with the patient and stored in the computing system;

prepare to transmit the augmented electronic medical data to another external computing device operated by another third party by:

determine, by reference to the exam type data structure, a received exam type associated with the another third party and corresponding to the matching master exam type or the one of the master exam types; and

associate the determined received exam type with the augmented electronic medical data; and

transmit the augmented electronic medical data to the another external computing device operated by the another third party.

27. The computing system of claim **25**, wherein the one or more computer processors are configured to execute the stored electronic software instructions to further cause the computing system to:

in response to determining that the measure of confidence does not satisfy the predetermined threshold:

determine, by automated analysis of the electronic medical data, at least one additional of the master exam types that closely matches the received exam type of the received exam after the one of the master exam types;

prompt a user of the computing system to select a matching master exam type from the group consisting of: the one of the master exam types, and the at least one additional of the master exam types;

associate the received exam type of the received exam with the selected matching master exam type;

associate the received exam with the selected matching master exam type; and

execute one or more rules associated with the selected matching master exam type on the received exam.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 9,092,727 B1
APPLICATION NO. : 13/572552
DATED : July 28, 2015
INVENTOR(S) : Murray A. Reicher

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On The Title Page

In column 2 (page 4, item 56) at line 1, Under Other Publications, change "Browers-based" to --Browsers-based--.

In column 1 (page 5, item 56) at line 6, Under Other Publications, change "12 page.," to --12 pages,--.

In column 1 (page 5, item 56) at line 23, Under Other Publications, change "Incoprorated." to --Incorporated.--.

In column 1 (page 5, item 56) at line 30, Under Other Publications, change "Techology" to --Technology--.

In column 2 (page 5, item 56) at line 4, Under Other Publications, change "Healcare," to --Healthcare,--.

In column 2 (page 5, item 56) at line 39, Under Other Publications, change "Vixtek" to --Viztek--.

In column 2 (page 6, item 56) at line 33, Under Other Publications, change "Incoprorated." to --Incorporated.--.

In The Specification

In column 3 at lines 59-61, Delete "include performance by any one or more of the computing devices noted herein and/or any other suitable computing device." and insert the same on Col. 3, Line 58, as the continuation of the same paragraph.

In The Claims

In column 14 at line 62, In Claim 14, change "matching master" to --master--.

Signed and Sealed this
Eighth Day of March, 2016

Michelle K. Lee

Michelle K. Lee
Director of the United States Patent and Trademark Office